PREASSESSMENT SCREEN AND DETERMINATION FOR THE DIAMOND ALKALI SUPERFUND SITE NEWARK, ESSEX COUNTY, NEW JERSEY

ISSUED BY:
THE STATE OF NEW JERSEY
DEPARTMENT OF ENVIRONMENTAL PROTECTION

THE UNITED STATES DEPARTMENT OF COMMERCE
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION

AND THE
UNITED STATES DEPARTMENT OF THE INTERIOR
U.S. FISH AND WILDLIFE SERVICE

IN THEIR CAPACITY AS
NATURAL RESOURCE TRUSTEES
AUGUST 2004

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EXECUTIVE SUMMARY

The tidal portion of the Passaic River has a rich and diverse history that includes broad public interest in, and use of, the numerous natural resources provided by this region. Many of the region's environmental, cultural, and economic resources have been adversely affected by industrial and urban development. Contamination of these natural resources by releases of hazardous substances is one significant cause of adverse impacts. One prominent hazardous substance released into the environment in the area is 2,3,7,8-tetrachlorodibenzo-*p*-dioxin (2,3,7,8-TCDD), which is highly toxic and can become concentrated to extremely high levels in organisms, even when concentrations are relatively low in water, sediment or soil. This hazardous substance has contaminated the Diamond Alkali Superfund Site at near record-concentrations documented for any aquatic environment. This contamination originated primarily from industrial discharges into the Passaic River, which includes the Diamond Alkali Plant.[1] This hazardous substance, 2,3,7,8-TCDD poses a substantial threat to natural resources.

The Diamond Alkali Superfund Site[2] is defined by the United States Environmental Protection Agency (USEPA) as "...the tidal portion of the Passaic River, including the Passaic River Study Area ... and the areal extent of contamination to which hazardous substances from the Study Area were transported, have or may have migrated or threatened to migrate or have come to be located and shall also include those sources from which contamination outside of the Study Area may be transported, have or may have migrated or threatened to migrate or have come to be located within the Study Area."

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[1] In addition to 2,3,7,8-TCDD, there are other hazardous substances which have contaminated the tidal portion of the Passaic River which originate from sources other than the Diamond Alkali Plant. Those hazardous substances include polychlorinated biphenyls (PCBs), polycyclic aromatic hydrocarbons (PAHs), heavy metals and pesticides. In order to comply with 43 C.F.R. Part 11, Subpart B, Sections 11.23-11.25 (relating to the Preassessment Screen), the Trustees, among other things, are to determine whether there is a reasonable probability of making a successful claim against parties responsible for releasing hazardous substances into the environment. Because information regarding 2,3,7,8-TCDD is presently more readily available, the Trustees in this Preassessment Screen will concentrate to a great extent upon that substance and its source in order to meet the threshold requirements of the regulations. That is not to say that other hazardous substances and the sources thereof are not important factors in the contamination of the Passaic River and its environs, but only that in order to begin to perform the assessment, the collection of information on 2,3,7,8-TCDD and the Diamond Alkali Plant as its source is the furthest along. It is anticipated that during the assessment, other hazardous substances and their sources may also be studied. In other words, the focus in this Preassessment Screen should not be construed as an indication that the Trustees at this time are only interested in dioxin or the Diamond Alkali Plant; it is merely a starting point. Indeed, in accord with that view, the USEPA has in the past issued notices to numerous parties which may be potentially liable with respect to the contamination in the Lower Passaic River, and in fact, USEPA recently entered into an Administrative Order on Consent with over thirty (30) parties to fund an investigation of that portion of the River. Additionally, the NJDEP issued Directive No. 1 on September 19, 2003 which documented the presence of numerous hazardous substances in the Passaic River and Passaic River sediments.

[2] USEPA Region 2 Request for Information Letter to Potentially Responsible Parties, dated February 27, 2003. Standard USEPA Notice in Hazard Ranking System package clarifying what a National Priorities Site represents, specifically the Diamond Alkali Superfund Site, dated July 31, 1995.

The Passaic River Study Area[3] ("PRSA") was initially a six-mile stretch of the Lower Passaic River; it has been expanded by USEPA to include contaminated sediments and other potential sources of hazardous substances along the entire 17-mile tidal reach of the Lower Passaic River. Therefore references to the Diamond Alkali Superfund Site, or the Site, includes the Diamond Alkali Plant (described below), the 17-mile tidal reach of the Lower Passaic River, and other areas where hazardous substances therefrom were transported, have or may have migrated or threaten to migrate or have come to be located and shall also include those sources from which contamination outside of the entire 17-mile Study Area may be transported (see Figure 1.), have or may have migrated or threatened to migrate or have come to be located within that Study Area. It is also important to note that an additional study of Newark Bay (also referred to below) will also be undertaken to determine if contamination extends farther than the 17-mile PRSA.

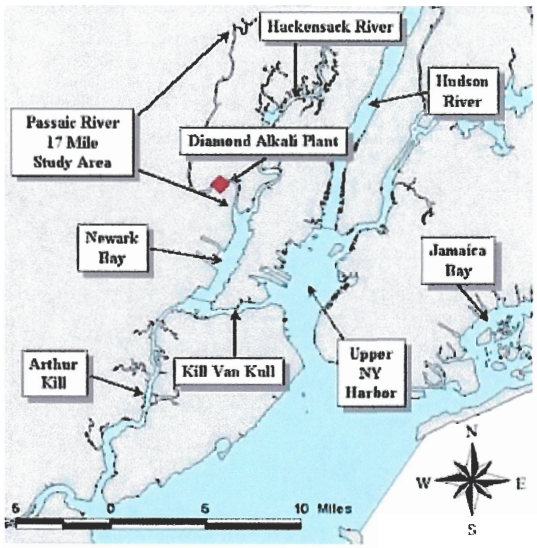


Figure 1. Newark Bay Complex and neighboring waterways

The Diamond Alkali Plant[4], within the Diamond Alkali Superfund Site, at 80 and 120 Lister Avenue, Newark, NJ ("Plant") is located on the western shore of the Passaic River, approximately three miles upstream from its confluence with Newark Bay. The Plant has been used for chemical manufacturing for over 100 years by several parties, with dichlorodiphenyltrichloroethane (DDT) and phenoxy herbicide production beginning in the mid-1940's. 2,3,7,8-TCDD as well as other polychlorinated dibenzo-*p*-dioxins (PCDDs) and polychlorinated dibenzofurans (PCDFs) were produced there as a byproduct of the production of phenoxy herbicides. The Plant has also been cited as an important source of PCDFs and DDT.

The Newark Bay Study Area[5], referred to in the February 13, 2004 USEPA Region 2 Administrative Order On Consent For Remedial Investigation and Feasibility Study (RI/FS) and Appendix 1 - Statement of Work, includes Newark Bay, and portions of the

[3] USEPA Region 2 Notice of Potential Liability for Response Actions in the Lower Passaic River to Potentially Responsible Parties dated September 15, 2003.

[4] The Trustees note that there are additional hazardous substances and other sources of contamination to the Site and the Passaic River, e.g. see footnote 3 above. These may be addressed in this or future investigations conducted by the Trustees as warranted.

[5] Administrative Order On Consent and Accompanying Remedial Investigation and Feasibility Study - Statement of Work, USEPA Region 2, February 13, 2004.

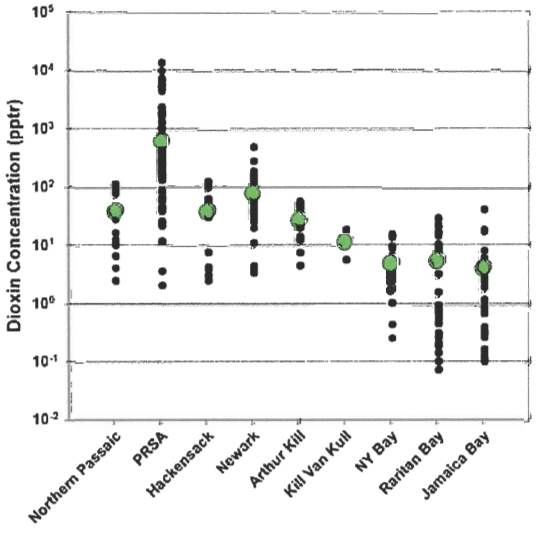
Hackensack River, Arthur Kill, and Kill Van Kull. The purpose of the RI/FS is to determine the nature and extent of contamination within the Newark Bay Study Area.

Areas and Resources Affected by the Release[6]: The Diamond Alkali Plant, Lower Passaic River and Newark Bay Study Areas (collectively, the Diamond Alkali Superfund Site or "Site"), and other areas where hazardous substances have come to be located, are the areas of concern for this Preliminary Assessment Screen. These areas provide significant ecological, economic and cultural resources for the greater New York/New Jersey Harbor region. The services provided by these resources include recreational activities such as fishing, boating, and viewing wildlife; commerce; and ecological functions, such as feeding, breeding, and nursery habitat for 75 aquatic species. The Site lies within the Newark Bay Complex. Because information included in this PAS strongly suggests the Newark Bay Complex has also been affected by the release, the trustees may address the Newark Bay Complex in this or future investigations.

The Natural Resource Damage Assessment Process: Various laws designate Federal and state authorities that may act on behalf of the public as natural resource trustees. Trustees can pursue claims for natural resource damages for injury to, destruction of, or loss of natural resources resulting from the release of hazardous substances to the environment. The formal process by which Trustees evaluate the impacts of hazardous substances on natural resources is known as a natural resource damage assessment, or NRDA.

The first step in developing a NRDA is the preparation of this document, a Preassessment Screen ("PAS"), which provides a review of readily available information on the release of hazardous substances and their potential impacts on publicly-held natural resources. This review ensures that there is reasonable probability of making a successful claim against a responsible party, and also documents whether further investigation and assessment efforts are warranted.

Figure 2. Dioxin (2,3,7,8-TCDD) concentrations in surficial sediments of the Newark Bay Complex and neighboring waterways (NOAA, 2002)



Exposure and Potential Natural Resource Injuries: Starting in 1983, elevated levels of 2,3,7,8-TCDD and other chemicals originating from the Plant have been detected in a variety of

[6] The Newark Bay Complex includes the Passaic River downstream of the Dundee Dam, Newark Bay, the Hackensack River downstream of Oradell Dam, the Arthur Kill, Kill Van Kull and associated waterways.

environmental media, especially soils and groundwater on the terrestrial portion of the Site and in the sediment and biota of the Complex.

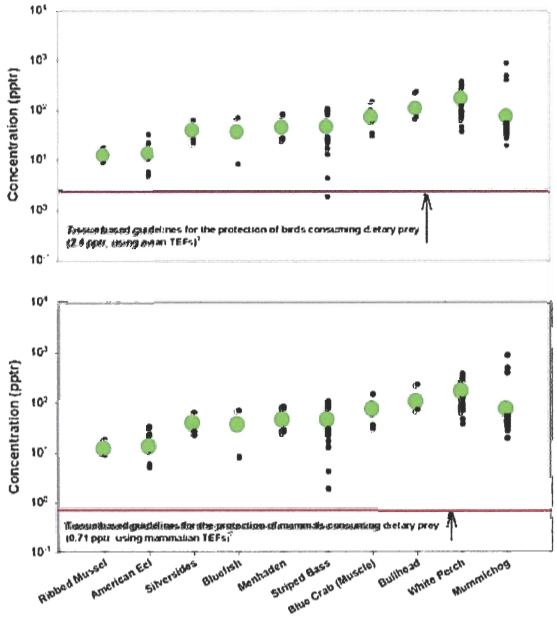
Sediments: Aquatic sediments are important habitat for many fish and shellfish species and play a key role in the storage and cycling of food, nutrients, and hazardous substances throughout the ecosystem. Several studies of the Site have documented the connection between very high levels of 2,3,7,8-TCDD in surface and subsurface sediments and releases at and from the Plant (see Figure 2.).

Navigation: Marine transportation is an important economic service provided by the Complex. The presence of 2,3,7,8-TCDD along with other hazardous substances in sediments has hindered dredging and maintenance activities for the purposes of navigation in the Port of New York and New Jersey, and resulted in restricted disposal options and increased costs.

Aquatic Biota: The Complex provides habitat for over 75 aquatic species, including 25 species that spawn there, including important prey species such as blueback herring, alewives, American shad, bay anchovy, mummichog, and striped killifish and predators such as striped bass and white perch. Elevated levels of 2,3,7,8-TCDD and 2,3,7,8-TCDD toxic equivalents (or toxicity equivalent/equivalence, TEQs) have been detected in various aquatic resources in the Passaic River (see Figure 3.).

Avian Resources: Over 70 species of birds are known to use habitats in the Complex, including approximately 1,200 pairs of colonial wading birds such as black-crowned night-herons, yellow-crowned night-herons, little blue herons, green herons, and great, snowy, and cattle egrets. Elevated concentrations of 2,3,7,8-TCDD and 2,3,7,8-TCDD TEQs in prey items and double-crested cormorant eggs indicate that migratory waterfowl and small mammals and aquatic biota in the Passaic River and Newark Bay Complex are also at risk from PCDD/DF, PCB and other potential contamination.

Figure 3. Passaic River biota TCDD TEQs and tissue residue guidelines for the protection of wildlife consumers of aquatic biota.



Fish Consumption Advisories and Bans: The Complex lies within a large metropolitan area that once provided valuable recreational and commercial fishing services to the surrounding

communities. Fish consumption advisories for the Passaic River were first issued in the early 1980's due to elevated levels of TCDD and PCBs in fish and crabs (see Figure 4.). Presently, due to TCDD contamination, the New Jersey Department of Environmental Protection (NJDEP) advises against consumption of all fish and shellfish, including blue crab taken from the Passaic River and its tributaries that feed into this section of the river. For that portion of the Newark Bay Complex below the mouth of the Passaic River including Newark Bay, the Hackensack River downstream of Oradell Dam, the Arthur Kill, Kill van Kull and their tidal tributaries, the NJDEP advisory includes "do not eat" recommendations for striped bass and blue crabs. There is also a "do not eat" advisory for American eel, white perch, and white catfish from these waters at a lifetime cancer risk of 1 in 100,000 for PCBs. High risk individuals (i.e., infants, children, pregnant women, nursing mothers and women of childbearing age) are advised to eat none of these species from any waterway within the Complex. Furthermore, selling of blue crab, striped bass, and American eel from these waters is prohibited, and blue crab can no longer be legally harvested. In the Passaic River downstream of Dundee Dam and streams that feed into this section of the river, it is illegal to harvest or sell blue crabs, and there is a general prohibition on the sale of all other fish and shellfish from these waters. Note that despite these advisories, certain fishermen routinely ignore the warnings and continue to take their catch home to feed their families.

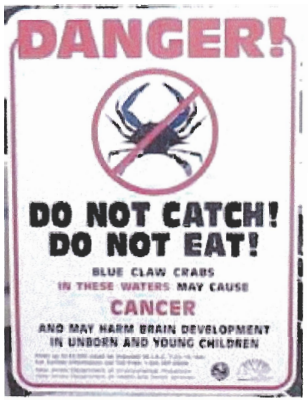


Figure 4. NJDEP crab advisory

Conclusion: A review of readily available information documents the releases of PCDD and PCDF compounds into the Passaic River. The overall distribution in sediment and biota, relative abundances of signature compounds, and history of PCDD releases into the system indicate that the Plant is an important source of PCDDs, especially 2,3,7,8-TCDD, for tidal reaches of the Complex, including the Passaic and Hackensack Rivers, Newark Bay, Kill van Kull, the Arthur Kill and associated waterways. 2,3,7,8-TCDD contamination is partly responsible for fish consumption advisories. Biological injuries to aquatic, as well as avian and mammalian species, may also be occurring from exposure to 2,3,7,8-TCDD and other related contaminants.

The Trustees conclude, therefore, that there is a reasonable probability of making a successful claim against the party or parties responsible for releases at and from the Diamond Alkali Superfund Site for natural resource damages related to the Site and resulting from releases of hazardous substances, including PCDDs, and that further investigation and assessment efforts are warranted which would include the identification of additional responsible parties as sources of hazardous substances in the Passaic River.

1.0 Introduction[7]

Following the authority of § 9607(f) of the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA)[8] and other applicable Federal and State laws, designated federal and State authorities may act on behalf of the public as natural resource trustees to pursue claims for natural resource damages for injury to, destruction of, or loss of natural resources resulting from the release of hazardous substances to the environment. Natural resource trustees may pursue claims against parties that have been identified as responsible for releasing hazardous substances to the environment. Under CERCLA, sums recovered by trustees as damages can be used only to restore, replace, or acquire the equivalent of such natural resources.

The first step in developing a natural resource damages claim is the preparation of a Preassessment Screen. The purpose of a Preassessment Screen is to provide a review of readily available information on hazardous substance releases and the potential impacts of those releases on natural resources under the trusteeship of Federal and State authorities. The review should ensure that there is reasonable probability of making a successful claim against parties responsible for releasing hazardous substances to the environment. A Preassessment Screen also documents the trustees' determination that further investigation and assessment efforts are justified.

This Preassessment Screen addresses potential claims for natural resource damages related to the Diamond Alkali Superfund Site, including the 17-mile Passaic River Study Area (PRSA). The Diamond Alkali Superfund Site is defined by the USEPA as:

"...the tidal portion of the Passaic River, including the Passaic River Study Area ... and the areal extent of contamination to which hazardous substances from the Study Area

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[7] As already stated in footnote 1, "In addition to 2,3,7,8-TCDD, there are other hazardous substances which have contaminated the tidal portion of the Passaic River which originate from sources other than the Diamond Alkali Plant. Those hazardous substances include polychlorinated biphenyls (PCBs), polycyclic aromatic hydrocarbons (PAHs), heavy metals and pesticides. In order to comply with 43 C.F.R. Part 11, Subpart B, Sections 11.23-11.25 (relating to the Preassessment Screen), the Trustees, among other things, are to determine whether there is a reasonable probability of making a successful claim against parties responsible for releasing hazardous substances into the environment. Because information regarding 2,3,7,8-TCDD is presently more readily available, the Trustees in this Preassessment Screen will concentrate to a great extent upon that substance and its source in order to meet the threshold requirements of the regulations. That is not to say that other hazardous substances and the sources thereof are not important factors in the contamination of the Passaic River and its environs, but only that in order to begin to perform the assessment, the collection of information on 2,3,7,8-TCDD and the Diamond Alkali Plant as its source is the furthest along. It is anticipated that during the assessment, other hazardous substances and their sources may also be studied. In other words, the focus in this Preassessment Screen should not be construed as an indication that the Trustees at this time are only interested in dioxin or the Diamond Alkali Plant; it is merely a starting point. Indeed, in accord with that view, the USEPA has in the past issued notices to numerous parties which may be potentially liable with respect to the contamination in the Lower Passaic River, and in fact, USEPA recently entered into an Administrative Order on Consent with over thirty (30) parties to fund an investigation of that portion of the River. Additionally, the NJDEP issued Directive No. 1 on September 19, 2003 which documented the presence of numerous hazardous substances in the Passaic River and Passaic River sediments."

[8] As amended, at 42 U.S.C. § 9607(f).

were transported, have or may have migrated or threatened to migrate or have come to be located and shall also include those sources from which contamination outside of the Study Area may be transported, have or may have migrated or threatened to migrate or have come to be located within the Study Area."[9]

The PRSA was initially a six-mile stretch of the Lower Passaic River. This six mile stretch has been expanded by USEPA, to include contaminated sediments and other potential sources of hazardous substances along the entire 17-mile tidal reach of the Lower Passaic River.[10] The USEPA also recently designated a second major study area, the Newark Bay Study Area[11], to include Newark Bay, and portions of the Hackensack River, Arthur Kill, and Kill Van Kull. The Site and Study Areas comprise a large portion of the Newark Bay Complex, which includes the Passaic River downstream of the Dundee Dam, Newark Bay, the Hackensack River downstream of Oradell Dam, the Arthur Kill, Kill Van Kull and associated waterways. This Preassessment Screen was prepared in accordance with the Preassessment Screen provisions of the Federal regulations for Natural Resource Damage Assessments under CERCLA.[12] The natural resource trustees involved in this damage assessment include the Commissioner of the State of New Jersey Department of Environmental Protection (NJDEP), the Secretary of the U.S. Department of Commerce, acting through the National Oceanic and Atmospheric Administration (NOAA), and the Secretary of the U.S. Department of Interior (DOI), acting through the U.S. Fish and Wildlife Service (USFWS) (collectively, "Trustees").

A review of readily available information documents the releases of hazardous substances, including dioxins (polychlorinated dibenzo-*p*-dioxins or PCDDs) and furans (polychlorinated dibenzofurans or PCDFs) into the Lower Passaic River and Newark Bay Complex, especially 2,3,7,8-tetrachlorodibenzo-*p*-dioxin (2,3,7,8-TCDD) and 2,3,7,8-tetrachlorodibenzofuran (2,3,7,8-TCDF). The overall dioxin and furan releases as well as their distribution in sediment and impact on biota indicate that the Diamond Alkali Plant is an important source of dioxins and furans in the Lower Passaic River and Newark Bay Complex area as defined (Belton *et al.,* 1985; Tong *et al.,* 1990; Bopp *et al.,* 1991; Rappe *et al.,* 1991; Hauge *et al.,* 1994; Chaky, 2003), and that the Site is impacted by these hazardous substances. This information is the basis for asserting a claim. Specifically, the Trustees have determined that: (1) A release of a hazardous substance has occurred;

(2) Natural resources for which the Trustees may assert trusteeship under CERCLA have been or are likely to have been adversely affected by the release;

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[9] USEPA Region 2 Request for Information Letter to Potentially Responsible Parties, dated February 27, 2003. Standard EPA Notice in Hazard Ranking System package clarifying what a National Priorities Site represents, specifically the Diamond Alkali Superfund Site, dated July 31, 1995.

[10] USEPA Region 2 Notice of Potential Liability for Response Actions in the Lower Passaic River to Potentially Responsible Parties dated September 15, 2003.

[11] Administrative Order On Consent and Accompanying Remedial Investigation and Feasibility Study - Statement of Work , USEPA Region 2, February 13, 2004.

[12] At 43 CFR Part 11, Subpart B, §§ 11.23 through 11.25.

(3) The quantity and concentration of the released hazardous substance is sufficient to potentially cause injury to natural resources;

(4) Data sufficient to pursue an assessment are readily available or likely to be obtained at a reasonable cost; and

(5) Response actions, if any, carried out or planned are unlikely to sufficiently remedy the injury to natural resources without further action.

As evidenced by USEPA Region 2's Request for Information Letter to Potentially Responsible Parties of February 27, 2003, there are additional hazardous substances in, and other sources of contamination to, the Passaic River and the Complex. These other hazardous substances and their sources will be addressed in future investigations conducted by the Trustees.

1.1 Description of the Affected Environment

The Diamond Alkali Superfund Site includes the Diamond Alkali Plant locations at 80 and 120 Lister Ave, the study area encompassing the 17-mile Lower Passaic River and its tributaries, and the extent of contamination. In 1994[13], the USEPA identified the PRSA as that portion of the Passaic River from the abandoned ConRail Railroad bridge at the downriver boundary of the area located at the U.S. Army Corps of Engineers (USACE) station designation of 40+00 (i.e., a transect running perpendicular to the USACE Federal Project Limit for dredging 4,000 feet upstream from the red channel junction marker at the confluence of the Hackensack and Passaic Rivers) to a transect six miles (31,680 feet) upriver located at the USACE station designation of 365+80. In 2003, USEPA expanded the geographic scope of their investigation to currently encompass the 17-mile stretch of the Lower Passaic River and its tributaries extending from the Dundee Dam to Newark Bay. This integrated study between USEPA, the USACE, and the New Jersey Department of Transportation Office of Maritime Resources has been designated the

[13] Additionally, the Hazard Ranking System Package for the Site contains the following:
Identification Number: NJD980528996; Site Name: Diamond Alkali Co.; Region: 2.
This notice is included in the Hazard Ranking System package located within each Region docket and the Headquarters docket to clarify what the National Priorities Site, Diamond Alkali Co., represents. This has been added to ensure that the listing is consistent with policy.
When a site is listed, it is necessary to identify or define the release (or releases) encompassed with the listing. The approach generally used is to delineate a geographical area (usually the area within the installation or plan boundaries) and define the site by reference to that area. As a legal matter, the site is not coextensive with that area, and the boundaries of the installation or plan are not the "boundaries" of the site. Rather, the site consists of all contaminated areas within the area used to define the site, and any other location to which contamination from that area has come to be located.
While geographic terms are often used to designate the site (e.g., the "Jones Co. plant cite") in terms of the property owned by a particular party, the site properly understood is not limited to that property (e.g., it may extend beyond the property due to hazardous substance migration), and conversely may not occupy the full extent of the property (e.g., where there are uncontaminated parts of the identified property, they may not be strictly speaking, part of the "site"). The "site" is thus neither equal to nor confined by the boundaries of any specific property that may give the site its name, and the name itself should not be read to imply that this site is coextensive with the entire area within the property boundary of the facility or plant. The precise nature and extent of the site are typically not known at the time of listing.

Lower Passaic River Restoration Project. In 2004, the Newark Bay Study Area was also addressed by Administrative Order On Consent to include Newark Bay, and portions of the Hackensack River, Arthur Kill, and Kill Van Kull (USEPA, 2004). The Trustees may look within or beyond the areas described above, depending upon the severity and geographic extent of contamination.

Within the Site, the Newark Bay Complex is part of a highly industrialized urban watershed that drains portions of six counties and 32 municipalities in Bergen, Essex, Hudson, Middlesex, Union and Passaic counties in New Jersey, and Staten Island in New York. The 3.5 acre Diamond Alkali Plant at 80 and 120 Lister Avenue, Newark, New Jersey is located on the southern shore of the Passaic River, approximately three miles upstream from its confluence with Newark Bay and about 2 miles upstream from the downstream boundary of the PRSA. The Passaic River has a drainage area of approximately 762 square miles and an annual-mean flow of 1134 cubic feet per second (cfs) at the Little Falls New Jersey U.S. Geological Survey stream gaging station (USGS, 2004a). The drainage area of the Passaic River at Harrison/Newark is 923 square miles (USGS, 2004b). At the Passaic River mouth, the annual-mean freshwater flow was estimated to be approximately 1,450 cfs (IT Corporation, 1986).

2.0 Information on the Release of Hazardous Substances

As described below, the Trustees have obtained and reviewed readily available information concerning releases of dioxins and furans in particular (including 2,3,7,8-TCDD), as well as other hazardous substances to the Passaic River and associated waterways.

2.1 History and Time, Quantity, Duration and Frequency of Releases[14]

The Diamond Alkali Plant ("Plant") at 80 and 120 Lister Avenue had a long history of industrial development and chemical manufacturing dating back to the 1870's. The earliest records document that Lister Agricultural Chemical Company operated at this location. Agricultural chemicals are known to have been produced at the Plant since 1914 (Winfield, 2002). When Lister ceased operations in the 1940's, a portion of the property was eventually acquired by Kolker Chemical Works. Manufacturing operations by Kolker related to the current site conditions commenced in the mid-1940s, including the production of DDT and phenoxy herbicides (USEPA, 1987). Hexachlorobenzene, ovex (a miticide), lindane, low gamma-benzene hexachloride (low gamma-BHC), and derivatives of benzene sulfonyl chloride and sulfonates were also produced, but on a smaller scale. The estimated total production, in million lbs, of products by Kolker Chemical Works, were 2,4-D: 85; 2,4,5-T: 25; DDT: 100; HCB: 10; Ovex: 10; lindane: unknown; and low gamma-BHC: < 10 (IT Corporation, 1985a).

[14] The following information regarding the corporate history of the Diamond Alkali Company and ownership of the Diamond Alkali Plant is based on an evaluation of currently available information. These descriptions are subject to amendment, if warranted.

From March 1951 until 1971, the Diamond Alkali Company (which changed its name to Diamond Shamrock Corporation in 1967) owned/operated a plant at 80 Lister Avenue in Newark (the Diamond Alkali plant). The corporate history of the Diamond Akali Company is complicated, but worthy of note because it caused the original release of dioxin, which is one of the principal contaminants of concern in the River. As noted, Diamond Alkali Company changed its name in 1967 to Diamond Shamrock Corporation. Thereafter, as part of a corporate restructuring in 1983, Diamond Shamrock Corporation changed its name to Diamond Shamrock Chemicals Company (and at the same time a stock holding company was formed under the name Diamond Shamrock Corporation). Diamond Shamrock Chemicals Company at that point was made a subsidiary of the new Diamond Shamrock Corporation. In September 1986, the new Diamond Shamrock Corporation transferred all of the outstanding stock in Diamond Shamrock Chemicals Company to Oxy-Diamond Alkali Corporation, which was a wholly-owned subsidiary of Occidental Petroleum Corporation. Diamond Shamrock Chemicals Company was then renamed Occidental Electrochemicals Corporation. Effective in November 1987, Occidental Electrochemicals Corporation was merged into Occidental Chemicals Corporation, also a wholly-owned subsidiary of Occidental Petroleum Corporation.

Title to the Plant is also complicated. In 1971, the old Diamond Shamrock Corporation sold the Diamond Alkali plant at 80 Lister Avenue to Chemicaland Corporation, which also conducted chemical manufacturing activities there. Sometime between 1971 and 1980, Chemicaland sold the plant to an unrelated entity, and then in 1986, it was reconveyed to Diamond Shamrock Chemicals Company (i.e., the old Diamond Shamrock Corporation f/k/a Diamond Alkali Company). (A few years prior to that time, Diamond Shamrock Chemicals Company had acquired property at 120 Lister Avenue, adjacent to the 80 Lister Avenue parcel, for use in the removal activities noted above.) Later in 1986, title to both the 80 and 120 Lister Avenue properties was transferred by way of an intra-holding company transaction to Diamond Shamrock Chemical Land Holdings, Inc., a wholly-owned subsidiary of Diamond Shamrock Corporation. Thereafter, Diamond Shamrock Chemical Land Holdings, Inc. changed its name to Chemical Land Holdings, Inc., and became a subsidiary of Maxus Energy Corporation. Chemical Land Holdings, Inc. subsequently changed its name to Tierra Solutions, Inc.

The Diamond Alkali Co. (subsequently known as Diamond Shamrock) acquired the property in 1951 and began intensive production of 2,4,5-triclorophenol, a precursor of 2,4,5-trichlorophenoxy acetic acid (2,4,5-T) and other phenoxy herbicides. Herbicides based upon 2,4,5-T were major components of the defoliant Agent Orange, which was manufactured at the Plant between 1951-1969. More than 3.1 million liters (>820,000 gallons) of Agent Orange were produced during the Vietnam War (Maxus Energy Corp v. United States of America, 1992). Dioxins and furans, such as 2,3,7,8 TCDD and 2,3,7,8-TCDF, are unwanted byproducts of the production of phenoxy herbicides, which includes 2,4,5-T. Dioxins and furans are also produced in other chemical processes and via combustion.

Diamond Alkali transferred production of many of its products (e.g., lindane, DDT, low gamma-BHC) to other locations starting in the mid-1950's. Diamond Alkali's 80 and 120

Lister Avenue operations became focused on phenoxy herbicides and their intermediates. After a 1960 explosion in the trichlorophenol unit, production of ovex, HBC and benzene sulfonyl derivatives ceased. During the 1960's, about 15 million pounds of phenoxy compounds were produced annually. Manufacturing of phenoxy herbicides and their intermediates ceased in August 1969. Chemicaland Co. purchased the property in 1971 with the intent of producing benzyl alcohol. When production of benzyl alcohol was not profitable, Chemicaland contracted Diamond Shamrock to produce 2,4-dichlorophenoxy acetic acid (2,4-D). Limited quantities of 2,4-D were produced in 1974-1976 with maximum monthly output reported around 500,000 lbs. Occidental Chemical Co. managed the plant for Chemicaland Co. between late 1976 and early 1977. Chemicaland Co. closed the plant in February 1977. The property was idle from 1977 through 1980. Subsequent companies used the property until 1983 (USEPA, 1987). In 1983, sampling on the site and from the Passaic River revealed high levels of 2,3,7,8-TCDD (USEPA, 1987). The Plant was owned by Marisol, Inc. at the time of discovery in 1983. Occidental Chemical Corporation is a successor to the Diamond Shamrock Chemicals Company and has been named by the USEPA as the party required to perform response activities related to releases of hazardous substances at and from the Plant (USEPA, 1989).

It is estimated that between the mid-1940s and Plant closure 20 years later, over two hundred million pounds of herbicides (IT Corporation, 1985a) and byproducts, including 2,3,7,8-TCDD and related dioxins and furans, were produced. Bopp *et al.* (1991) estimated that 4-8 kg (8.8 - 17.6 lbs) of 2,3,7,8-TCDD were deposited in Newark Bay over a 40-year period from the Plant, ranking it as one of the largest releases ever recorded. During sampling in 1983, the USEPA reported elevated levels of 2,3,7,8-TCDD in soils and groundwater (USEPA, 1987). The Site was placed on the National Priorities List (NPL) in 1983. Results of the subsequent remedial investigation led the USEPA to conclude in the 1987 Record of Decision (ROD) that 2,3,7,8-TCDD is the primary hazardous substance of concern with respect to the Site.

A remedial investigation determined that hazardous substances have migrated from the Plant into the Passaic River via stormwater runoff, groundwater flow, flooded sewer lines, a Plant explosion that occurred in 1960, occasional inundation during storm surges (IT Corporation, 1985a, 1985b, 1986), and direct discharges (Diamond Shamrock Chemicals Company v. Aetna Casualty and Surety Company et al. 1989). USEPA's ROD agreed that the remedial investigation indicated that hazardous substances were being released at the time the ROD was signed (USEPA, 1987). Sampling in the original six mile portion of the PRSA demonstrated the presence of 2,3,7,8-TCDD at concentrations ranging from 2 parts per trillion (pptr) to 13,500 pptr in surface sediments. Higher concentrations have been measured at depth with a maximum concentration of 5,300,000 pptr 2,3,7,8-TCDD recorded adjacent to the Plant at the 4.5-5.5 ft depth interval (NOAA 2004). Radiolabeled sediment cores revealed concentrations of 2,3,7,8-TCDD of 1,100 pptr in Newark Bay, 150 pptr in Upper New York Bay, less than the detection limit (DL) of 60 pptr) upstream of the Dundee Dam, and 7,600 pptr near the Site during the mid-1960's (Bopp *et al.*, 1991).

PCDD/DFs have also been found in sediments, aquatic life and birds from the Complex (see Section 3.2, below and Bopp *et al.*, 1991; Brown *et al.*, 1994; Cai *et al.*, 1994a; Long *et al.*, 1995; Parsons, 2003) at concentrations higher that in the New York Bight Apex (NOAA, 1996). Belton *et al.* (1985, 1988), Rappe *et. al.* (1991) and Hauge, et. al., (1994) suggested that 2,3,7,8-TCDD contamination of fish and shellfish from the New York/New Jersey (NY/NJ) Harbor Estuary likely derived from 2,3,7,8-TCDD-contaminated Passaic River sediment in the vicinity of the Plant. 2,3,7,8-TCDD/DF and p,p'-dichlorodiphenyldichloroethane (p,p'-DDD) in the Newark Bay Complex have sediment profiles and a history of releases that tie their presence to local industrial production of 2,4,5-T and DDT (Bopp *et al.*, 1991). "Fingerprinting" using ratios of 2,4,6,8-tetrachlorodibenzothiophene (2,4,6,8-TCDT) and 2,3,7,8-TCDD (Cai *et al.*, 1994b) provides further evidence regarding the source of dioxins in biota and sediments of Newark Bay Complex. The overall distribution, relative abundances of signature compounds, and history of dioxin releases into the Complex indicate that the Diamond Alkali Superfund Site is the major source of dioxin to the Complex and that the Site is contaminated with Plant-related hazardous substances (Bopp *et al.*, 1991; Cai *et al.*, 1994a).

2,3,7,8-TCDD contamination in the NY/NJ Harbor is dominated (even in recently deposited sediments, up to 50%) by the Diamond Alkali source to the Passaic River (Chaky, 2003). This signal can be detected in the Hudson River to at least Hastings, NY at River Mile 26. The signal also appears in a Raritan Bay sediment core below the Arthur Kill. This determination is derived from an analysis of ratio of 2,3,7,8-TCDD to the sum of the tetra-substituted dibenzo-*p*-dioxins. The value (about 0.7) is an order of magnitude higher in sediments influenced by 2,4,5-T production than from non-2,4,5-T production sources. Newark Bay Complex 2,3,7,8-TCDD and homolog sediment data from an independent set of sediment samples (NOAA, 2004) yields an average value of 0.69 (n=371), similar to that reported by Chaky (2003).

2.2 Hazardous Substances Released

PCDD/DFs are present as trace impurities in some commercial herbicides, and chlorophenols (Rice *et al.*, 2003). They can also be formed as a result of photochemical and thermal reactions in fly ash and other incineration products (Rice *et al.*, 2003). PCDFs are also impurities of PCBs and catastrophic events can augment the concentrations of PCDDs/DFs (Rice *et al.*, 2003).

The most extensively studied PCDD/DF congener, 2,3,7,8-TCDD, is also the most toxic. 2,3,7,8-TCDD is among those hazardous substances listed under CERCLA[15] and it is also one of the most toxic synthetic compounds ever tested under laboratory conditions (Eisler, 2000). 2,3,7,8-TCDD is the major PCDD/DF congener of toxicological concern produced during the synthesis of 2,4,5-trichlorophenol, which is used in the manufacture of the herbicide 2,4,5-T, and other trichlorophenoxy acids. 2,3,7,8-TCDD is exceedingly

[15] 2,3,7,8-TCDD is among those substances listed in Table 302.4, List of Hazardous Substances and Reportable Quantities under CERCLA (40 CFR § 302.4(a)), and listed as a toxic pollutant pursuant to 40 CFR § 401.15, as amended.

stable, readily incorporated in aquatic and terrestrial ecosystems, extremely persistent in the environment. Indeed, biotic and abiotic peridechlorination of PCDDs may actually increase the levels of 2,3,7,8-TCDD in sediment (Barkovskii and Adriaens, 1998, Rice *et al.*, 2003).

In addition, 2,3,7,8-TCDD has a strong tendency to bioaccumulate (Hoffman *et al.*, 1996; Eisler, 2000; Rice *et al.*, 2003). Consequently, predator species may experience significant dietary exposure through food chain transfer and bioaccumulation, even when concentrations in water and sediments are extremely low. Biological effects associated with 2,3,7,8-TCDD include lethality, carcinogenicity, embryotoxicity, teratogenicity, reproductive impairment, and immunotoxicity (Rice *et al.*, 2003). The fate and effects of PCDD/DF, especially 2,3,7,8-TCDD, and other dioxin-like compounds, e.g., coplanar PCBs, their role in the toxicity to humans, aquatic organisms, wildlife, livestock, poultry, and their contamination of vegetation, soils, and sediments have been extensively reviewed (see ATSDR, 1998; WHO, 2000; Eisler, 2000; Rice *et al.*, 2003). PCDD/DFs and coplanar PCBs, chemical cousins to 2,3,7,8-TCDD, exert similar toxicological effects in vertebrate organisms and therefore must also be looked at when assessing natural resource injuries. An additive model has been developed to characterize TEQs for PCDDs, PCDFs and coplanar PCBs relative to 2,3,7,8-TCDD toxicity (Van den Berg *et al.*, 1998). Congener concentrations are multiplied by their respective toxic equivalency factor (TEF) to generate a TCDD-TEQ. The Plant has also been cited as an important source of PCDFs such as 2,3,7,8-TCDF which can also be produced as a hazardous substance during 2,4,5-trichlorophenate synthesis (Bopp *et al.*, 1991). PCDD/DFs and PCBs are found within the Passaic River, the Complex and associated waterways. The maximum concentrations of 2,3,7,8-TCDF are found in Passaic River sediment cores, one located slightly upstream of the Plant (21,000 pptr) and the other in a sample adjacent to the Plant (17,800 pptr). The total PCB maximum concentration was 47.7 ppm in a Passaic River core slightly downstream of the Plant.

2.3 Additional Hazardous Substances Potentially Discharged or Released

Volatile organics, pesticides, herbicides, PAHs, PCBs, base neutral acids (BNAs), and metals present on the Diamond Alkali property are also the legacy of manufacturing operations. As noted in § 2.1 above, the Diamond Alkali Plant also synthesized 100 million pounds of DDT from the early 1940's until 1959 and has been reported to be the dominant historical source of DDT-related compounds to Newark Bay sediments (Bopp *et al.*, 1991). Hexachlorobenzene, ovex, lindane, low gamma-BHC, and derivatives of benzene sulfonyl chloride and sulfonates were also produced, but on a smaller scale. Various pesticides including DDT and volatile organic compounds have been found in the soil and groundwater samples on and near the Plant (IT Corporation, 1985a; USEPA, 1987). In addition, pesticides such as DDT and volatile organic compounds such as acetone and chlorobenzene have been found in the Passaic River near the Plant (McLaren/Hart 1995; NOAA, 2004). Hazardous substances, other than PCDD/DFs, related to Plant manufacturing activities, as well as from other dischargers, are found

within the Passaic River, the Complex and associated waterways. The Trustees will investigate these hazardous substances as part of the assessment process in the future.

2.4 Potentially Responsible Parties – Diamond Alkali Plant

As noted in 2.1 above, Kolker Chemical Works, Inc. produced phenoxy herbicides and DDT along with other agricultural chemicals beginning in the 1940s. Following purchase of the Plant in 1951, Diamond Alkali (subsequently known as the Diamond Shamrock Chemicals Company) focused on the production of 2,4,5-trichlorophenol, a precursor of 2,4,5-trichlorophenoxy acetic acid and other phenoxy herbicides. 2,4,5-T is used in the production of Agent Orange, an herbicide produced at the Plant during the Vietnam War. The Plant was owned by Marisol, Inc. at the time of discovery in 1983. Occidental Chemical Corporation is a successor to the Diamond Shamrock Chemicals Company, and has been named by the USEPA as a party required to perform cleanup activities with respect to the Site.

The Trustees believe they can demonstrate that Occidental Chemical Corporation, and its successors and predecessors, are a contributor of 2,3,7,8-TCDD and other hazardous substances to the Site, and therefore is a potentially responsible party under CERCLA. Other hazardous substances and other sources will be investigated as the NRDA process continues.

2.5 Damages Excluded from Liability under the Comprehensive Environmental Response, Compensation and Liability Act or the Clean Water Act[16]

The CERCLA regulations[17] provide that the Trustees must determine whether the damages being considered are barred by specific defenses or exclusions from liability under CERCLA or the Clean Water Act (CWA). The Trustees have made such determinations and believe that such defenses or exclusions from liability are without merit.

The Trustees must determine whether: (i) damages resulting from the discharge or release were specifically identified as an irreversible and irretrievable commitment of natural resources in an environmental impact statement or other comparable environmental analysis, that the decision to grant the permit or license authorizes such commitment of natural resources, and that the facility or project was otherwise operating within the terms of its permit or license, so long as, in the case of damages to an Indian tribe occurring pursuant to a federal permit or license, the issuance of that permit or license was not inconsistent with the fiduciary duty of the United States with respect to such Indian tribe; or (ii) the release of a hazardous substance from which the damages have resulted has not occurred wholly before the enactment of CERCLA; or (iii) damages resulted from the application of a pesticide product registered under the Federal Insecticide, Fungicide, and

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[16] Federal Water Pollution Control Act (commonly known as the Clean Water Act) 33 U.S.C. 1251-1376.

[17] At 43 CFR Part 11.24.

Rodenticide Act, 7 U.S.C. § 135-135k; or (iv) damages resulted from any other federally permitted release, as defined in § 101(10) of CERCLA; or (v) damages resulted from the release or threatened release of recycled oil from a service station dealer described in § 9607(a)(3) or (4) of CERCLA if such recycled oil is not mixed with any other hazardous substance and is stored, treated, transported or otherwise manage in compliance with regulations or standards promulgated pursuant to § 6935 of the Solid Waste Disposal Act[18] and other applicable authorities.

The Trustees must also determine whether the discharge meets one or more of the exclusions provided in § 1321(a)(2) or (b)(3) of the CWA.

The Trustees do not believe that any of the potential injuries referred to herein meet one or more of the above criteria, nor are they subject to the exceptions to liability provided in §§ 9607(f), (i), and (j) and 114(c) of CERCLA, and § 1321 (a)(2) or (b)(3) of the CWA. Therefore, the damage assessment may proceed.

3.0 Preliminary Identification of Resources Potentially at Risk

3.1 Preliminary Identification of Pathways

The manufacturing history of the Plant has been described briefly above and in detail in the Site Evaluation and Feasibility Study reports (IT Corporation, 1985a; 1985b). Diamond Alkali (Diamond Shamrock) operated the plant from 1951 to 1969, during which time it was predominantly devoted to pesticide and herbicide production. Dioxins and furans identified in Plant soils (Umbreit *et al.*, 1986, 1987) originated as a byproduct from 2,4,5-trichlorophenoxyacetic acid production.

3.1.1 Surface Water Pathways

The remedial investigation conducted by IT Corporation (1985a, 1985b, 1986) determined that contamination migrated from the Plant into the Lower Passaic River and associated waters via stormwater runoff, flooded sewer lines, and occasional inundation during storm surges. Sewer pipes, when not flooded, also acted as a conduit for chemical waste discharges to the Lower Passaic River. Four sewer and eight sump pump samples at the 80 Lister Avenue property were analyzed and tested positive for 2,3,7,8-TCDD and ranged from 105,000 to 9,160,000 pptr (USEPA, 1987). A change in the handling of process effluent occurred in 1956 with the installation of an industrial sewer connecting the Passaic Valley Sewerage Commission (PVSC) Lister Avenue Line. Following installation of that connection, it was believed that process wastes from the plant were discharged to the PVSC system, thus terminating direct discharge to the Lower Passaic River. However, in 1960, during work required to stabilize the river bank near the Plant, several sewer pipe discharge lines to the river were discovered. A civil action determined that Diamond Shamrock intentionally and willfully discharged wastes directly to the Passaic River between 1951 and 1969 (Diamond Shamrock v Aetna Casualty and Surety

[18] 42 U.S.C. 6901 *et seq.*

Company *et al.,* 1989).[19] All of the underground contaminant conduits were ordered identified and plugged when the new bulkheads were constructed for the Plant and Lister Avenue properties as part of the remedy for Operable Unit-1 (USEPA, 1987; USEPA, 2001). Occidental Chemical Corporation initiated the remedy in 1995, Chemical Land Holdings began construction in the spring of 2000 (USEPA, 2001).

3.1.2 Groundwater Pathways

Groundwater elevation at the bulkhead of the Site is approximately two feet above mean sea level, which is the same surface water elevation as the Passaic River at the bulkhead (USEPA 1995). Groundwater flow changes in response to the tidal cycle of the Passaic River. In the northern portion of the property, flow travel is in the direction of and discharges into the river (USEPA, 1995). Limited information is available on groundwater contamination. Two sets of groundwater samples from the 80 Lister Ave. property were collected from eight on-site wells. 2,3,7,8-TCDD was detected in 15 of the 17 samples, with a maximum reported concentration of 10,400 pptr (USEPA, 1987). As part of the 1994 Remedial Design Investigation, groundwater was sampled twice in order to provide baseline information on groundwater quality and as a reference for future monitoring. Five wells were tested. 2,3,7,8-TCDD was detected in all wells at concentrations ranging from 81 to 28,000 pptr with the maximum concentration being recorded within 150 ft of the river in the vicinity of the elevated soil samples (USEPA, 1995). The Federal and NJ Maximum Contaminant Level (MCL) of 0.03 pptr 2,3,7,8-TCDD and the NJ Groundwater Quality Criteria (NJGQC) of 0.0002 pptr 2,3,7,8-TCDD (NJAC 7:9-6, Jan 7, 1993) were exceeded.

[19] "From 1951 until 1956, Diamond intentionally discharged all of its waste chemical effluent into the Passaic River. Such discharges had been forbidden by specific statutory enactment since at least 1931…in 1956, the Passaic Valley Sewerage District became insistent upon compliance with the no-discharge law…Although Diamond purported to tie the whole Newark plant into the sewer in 1956, it actually tied only the 2,4-D building into the sewer. The chemical effluent from the main building continued to be discharged directly into the Passaic River…The discharges …were intentional, planned discharges from processing equipment through pipes or ditches. In addition, from 1951 through 1969, spills onto floors and ground surfaces drained mostly into the Passaic River. These spills were constant, and collectively, they were substantial in volume. Diamond was conscious that its discharges into the river were illegal. It deliberately concealed them, and over a period of many years employed an alarm system to warn employees to stop the discharges when Passaic Valley inspectors were on the premises." (pp. 8-9).

3.1.3 Airborne Pathways

In February of 1960, an explosion occurred in the trichlorophenol unit, which destroyed the large five-story building in which trichlorophenol was processed and other plant manufacturing activities were conducted (The Press of Atlantic City, 1988). Dioxins and furans are present as trace impurities in trichlorophenol production. These contaminants may also result from photochemical and thermal reactions in fly ash and other incineration products (Eisler 2000; Rice *et al.*, 2003). It is likely that the explosion provided a pathway for dioxins and furans to enter the air and the Passaic River. The ROD (USEPA, 1987) reports that 10 sets of ambient air samples were collected, although 2,3,7,8-TCDD was measured on only two sampling days. On those dates, 2,3,7,8-TCDD concentrations were 86 pg/m^3 and 286 pg/m^3.

3.1.4 Food Chain Pathways - - Bioaccumulation

2,3,7,8-substituted-dioxins/furans and PCBs are stored in the fatty tissue of organisms and bioaccumulate in the food chain (Eisler, 2000; Rice *et al.*, 2003). Aquatic organisms can accumulate 2,3,7,8-TCDD and other dioxin-like compounds from the water, sediment, or food. PCDD/DFs and PCBs have been measured in numerous species of aquatic biota and piscivorous wildlife in the Complex (see Section 3.2.4).

3.1.5 Particulate Movement Pathways

Dioxins and furans are adsorbed onto particulate matter suspended in the water column near the Plant, thereby contributing to the contaminant load further upstream and downstream. Suspended matter in the water column may lead to elevated dioxin and furan concentrations in aquatic biota and wildlife when consumed as part of their normal feeding activities.

3.1.6 Sediments as Pathways

Dioxins and furans in the effluent and surface runoff from the Plant traveled through surface water and groundwater, adsorbed onto particulate matter, and settled into the sediments. Dioxins, furans and similar compounds have been measured in sediment throughout the Lower Passaic River and the Newark Bay Complex, and the broader NY/NJ Harbor area (see Section 3.2.3) (NOAA, 2004; Chaky, 2003).

Once sediments are contaminated with dioxins and furans and similar compounds, they can be distributed throughout the estuary and serve as an ongoing source to the environment. Bottom-feeding fish, such as carp and catfish, from Michigan rivers contained higher 2,3,7,8-TCDD residues than surface feeders, indicating an association with contaminated sediments (Harless *et al.*, 1982).

3.1.7 Soils as Pathways

USEPA (1987) provides documentation on the concentrations of a variety of hazardous substances and flooding and stormwater runoff associated with the Plant and soils. Umbreit *et al.,* (1986, 1987, 1988a, 1988b) provide further characterization of the types, availability and toxicity of Diamond Alkali Plant soils. Chemical Land Holdings began remedial construction in 2000 to prevent continued surface and subsurface migration of 2,3,7,8-TCDD and other hazardous substances to the Passaic River (USEPA, 2001).

3.2 Exposed Areas

3.2.1 General

Dioxins and furans associated with releases from the Plant in Newark have been detected throughout the Newark Bay Complex, and have likely spread to contiguous waterways including the Hudson River, New York Bay, and Raritan Bay. Chaky (2003) attributes as much as 50% of the 2,3,7,8-TCDD in the Hudson River as far north as Hastings as originating from the Diamond Alkali Superfund Site. Chaky discusses the potential for using other tracers of sediment transport to Raritan Bay and the Harbor. The Trustees may extend their initial investigation of natural resource injuries from the area of highest contamination, i.e., the Complex, to other areas constituting portions of the Site where hazardous substance releases have migrated or come to be located and have caused natural resource injuries.

3.2.2 Exposed Surface Water Estimates and Concentrations

As part of the ROD, two Lower Passaic River water samples from 80 Lister Ave. were analyzed but 2,3,7,8-TCDD was not detected in either sample where the DL equaled 0.004 and 0.007 parts per billion (ppb) (USEPA, 1987). Two more surface water samples analyzed from 120 Lister Ave. resulted in one non-detect (DL = 0.0019 ppb) and one detect at 0.013 ppb 2,3,7,8-TCDD (USEPA, 1987). In comparison, the Federal Ambient Water Quality Criteria for protection of human health is 0.000000013 ppb 2,3,7,8-TCDD (water and organisms) and 0.000000014 ppb 2,3,7,8-TCDD (organisms only).[20] The New Jersey Water Quality Standard for protection of human health from 2,3,7,8-TCDD is 0.000000013 ppb in saltwater and 0.000000014 ppb in freshwater (NJDEP, 2003a). The New York State fresh and surface water and groundwater water quality standard for protection of human health from usage of a potable/drinking water source is 0.0000007 ppb. For protection of human health from fish consumption, the fresh and saline surface water quality standard for New York State is 0.0000000006 ppb. For the foregoing New York standards, the value is based on the total of the chlorinated 2,3,7,8-substituted dibenzo-*p*-dioxins and chlorinated dibenzofurans that are listed as equivalents of 2,3,7,8-tetrachlorodibenzo-*p*-dioxin (2,3,7,8-TCDD). For protection of wildlife from fish consumption, the New York State water quality standard is 0.0000000031 ppb as actual 2,3,7,8-TCDD (NYDEC, 1998). Detectable concentrations of 2,3,7,8-TCDD greatly exceeded these criteria and standards.

[20] Federal Register/Vol. 63, No. 237, Thursday, December 10, 1998.

3.2.3 Exposed Sediment Estimates and Concentrations

Surficial Sediments: Aquatic sediments are important habitat for many fish and shellfish species and play a key role in the storage and cycling of food, nutrients, and hazardous substances throughout the ecosystem. Several studies have drawn an association between discharges from the Site and the majority of dioxins and furans measured in sediments and biota from the area (Belton *et al.,* 1985; Belton *et al.,* 1988; Tong *et al.*, 1990; Bopp *et al.*, 1991; Rappe *et al.*, 1991; Hauge *et al.,* 1994).

For example, Bopp *et al.* (1991) detected elevated levels of 2,3,7,8-TCDD in sediment radiolabeled cores from the Passaic River, Newark Bay, and Hackensack River. They found that at each time horizon, the highest concentrations of 2,3,7,8-TCDD were found at the sampling locations adjacent to the Plant, with a maximum subsurface concentration of 21,000 pptr 2,3,7,8-TCDD in sediments that were estimated to have been deposited during the late 1950's to early 1960's. This time horizon coincides with the greatest releases from industrial activities (Bopp *et al.,* 1991; Tong *et al.*, 1990).

A similar spatial gradient is evident by examining the data from several other studies from 1990-2000 (Tables 2 and 3). Table 2 displays the surficial data (surficial sediments are reported at a depth of 0-15 cm (Maxus/USEPA collected samples; Maxus Energy Corp., 1993, 1994, 1995) and 0-2 cm (Strobel *et al.,* 1995; Adams *et al.,* 1998) from these studies. From within the original six-mile portion of the Lower Passaic River, 194 surficial sediment samples have been collected from 14 studies over a ten-year period, 1990-2000. Detectable sediment concentrations ranged from 2-13,500 pptr 2,3,7,8-TCDD, dry wt and 0.31 to 480 pptr, 2,3,7,8-TCDF dry wt, respectively (NOAA, 2004).

Surficial concentrations tend to decrease moving upstream and downstream away from the Plant. 2,3,7,8-TCDD detectable concentrations in 23 sediment samples collected north of the original six-mile portion of the PRSA ranged between 2.4-970 pptr. 2,3,7,8-TCDD in sediments from the Hackensack River ranged in concentrations from 2.4-188 pptr. 2,3,7,8-TCDD concentrations of Newark Bay surficial sediments ranged between 2.6–470 pptr . Surficial sediment 2,3,7,8-TCDD concentrations in other waterways tend to decrease moving away from Newark Bay (see Table 1.) and (Chaky, 2003).

Table 1. Concentrations of 2,3,7,8-TCDD in surficial sediments of NY/NJ Harbor waterways, 1990-2000 (NOAA, 2004).

Site	n	Range (pptr)	Average ± 1 std dev. (pptr)
Passaic River (North of Original PRSA)	23	2.4-970	277 ± 298
Original Passaic River Study Area (PRSA)	194	2-13,500	61.5 ± 1470
Hackensack River	10	2.4 -188	38 ± 43
Newark Bay	40	2.6 - 470	80 ± 83
Arthur Kill	14	7.3-55.8	28 ± 17
Kill Van Kull	2	1.8-18	12 ± 9
Upper New York Bay	16	0.3 - 15	5 ± 5
Lower Bay/Raritan Bay	28	0.1 - 28	6 ± 8
Jamaica Bay	28	0.1 - 39	4 ± 8

Sub-surface Sediments: Table 2. displays sub-surface data from several studies conducted in the early 1990's. During a four-year period (1991-1995), 594 subsurface sediment samples were collected during seven sampling events in the PRSA (NOAA, 2004). 2,3,7,8-TCDD concentrations ranged between 1-5,300,000 pptr. 2,3,7,8-TCDD concentrations in 24 subsurface samples collected north of the PRSA ranged between 0.7-720 pptr. Subsurface sediments from the Hackensack River ranged from 0.5-250 pptr. Newark Bay sub-surface sediments ranged between 1-630 pptr. Surface and subsurface sediments tended to display a similar spatial gradient, *i.e.,* decreasing away from Newark Bay (see Tables 1. and 2.).

Table 2. Concentrations of 2,3,7,8-TCDD in subsurface sediments of NY/NJ Harbor waterways, 1992-1995 (NOAA, 2004).

Site	n	Range (pptr)	Average ± Std Dev. (pptr)
Passaic River (North of Original PRSA)	24	0.7 - 720	62 ± 145
Original Passaic River Study Site Area (PRSA)	594	1-5,300,000	18,730 ± 228,580
Newark Bay	49	1 - 630	78 ± 122
Hackensack	12	0.5 - 250	93 ± 107
Arthur Kill	13	4 -80	35 ± 25
Kill Van Kull	8	0.6 - 130	21 ± 43
Upper New York Bay	1	1.8	-----

Sediment concentrations of 2,3,7,8-TCDD in the Complex remain among the highest cited for aquatic ecosystems (ATSDR, 1998). For comparison, the USEPA determined 2,3,7,8-TCDD contamination severe in Lake Ontario, Canada sediment, where a mean surface sediment concentration of 68 pptr was recorded in 1987 and a maximum subsurface sediment concentration of 500 pptr was recorded in the early 1960s (USEPA, 1993). Concentrations of 2,3,7,8-TCDD in the sediments of the Passaic River are one or more orders of magnitude greater than the levels seen in Lake Ontario. Dredge material from the greater NY/NJ Harbor have failed ocean disposal due to dioxins, furans and PCBs bioaccumulating in test organisms above trigger levels.

3.2.4 Exposed Biota Estimates and Concentrations

Aquatic Biota: The Complex provides habitat for over 75 aquatic species. Elevated levels of PCDDs have been detected in various aquatic resources in the Complex (Brown *et al.,* 1994; Cai *et al.,* 1994a; Long *et al.,* 1995; USFWS, 2000a,b). Eight surveys were conducted over six years (1995 - 2001) for various invertebrate and fish species from within the PRSA for dioxins, furans and other analytes. 2,3,7,8-TCDD results are summarized in Table 3. These data reveal significant 2,3,7,8-TCDD contamination in invertebrates such as blue crab and ribbed mussel, forage fish such as mummichog, Atlantic silverside, and menhaden, and higher predators such as striped bass, white perch, American eel, and bluefish.

Table 3. Concentrations of 2,3,7,8-TCDD in aquatic biota of the Lower Passaic River Study Area (Original six mile PRSA) (NOAA, 2004)

Species	n	Range (pptr)	Average ± Std Dev (pptr)
Blue crab (soft tissue, hepatopancreas, muscle)	62	7 – 6238	264 ± 901
Striped bass (whole body, standard fillet, no skin fillet)	25	2 – 101	45 ± 31
White perch (whole body, standard fillet, no skin fillet)	25	34 – 352	175 ± 96
American eel (whole body, standard fillet)	13	5 - 30	12.9 ± 7.5
Mummichog (whole body)	49	19 – 828	83 ± 133
Atlantic silverside (whole body)	9	21 - 60	41 ± 12
Bluefish (whole body, no skin fillet)	3	8 - 67	37 ± 30
Menhaden (whole body)	6	25 - 79	45 ± 25
Ribbed mussel (soft tissue)	15	9 - 17	12 ± 2
Brown bullhead (no skin fillet)	6	70-220	111.7 ± 54.6

These concentrations in white perch and mummichog are among the highest reported for wild fish (Sijm and Opperhuizen, 1996). 2,3,7,8-TCDD concentrations observed in mummichog, white perch and juvenile striped bass are near body burden levels (approximately 50 to 500 pptr) that may adversely affect early developmental stages of sensitive species of fish (Sijm and Opperhuizen, 1996). By comparison, in 90% of fish sampled at sites around the U.S., dioxin levels were below 5 pptr, making Passaic River fish among the most contaminated in the country. A no observed adverse effect level (NOAEL) for lake trout toxicity-related mortality of 5 pptr TCDD-TEQ/egg has been estimated (Cook *et al.,* 2003). These authors assumed a ratio of 0.69 egg to adult females.

Carp and catfish sampled in 1970 from South Vietnam had 2,3,7,8-TCDD concentrations ranging from 320 to 690 pptr and 52 to 1020 pptr, respectively (Baughman and Meselson, 1973). A recently published study of 2,3,7,8-TCDD contamination in Vietnam found average concentrations of 35 pptr and 67 pptr in carp and duck fat, respectively (Dwernychuk *et al.,* 2002*).* These samples were collected at a pond adjacent to a former Agent Orange storage facility. These elevated 2,3,7,8-TCDD concentrations were attributed to storage and spillage of Agent Orange. The highest concentration recorded in blue crab hepatopancreas from the Passaic River Study Area, 6283 pptr 2,3,7,8-TCDD (NOAA, 2004) exceeds the average concentration in carp from Vietnam (Dwernychuk *et al.,* 2002).

One way to evaluate the potential risk of organism body burdens of 2,3,7,8-TCDD is to compare them to "effect body burdens." 2,3,7,8-TCDD, other dioxins, furans and similar compounds elicit several responses in fish, including hepatic cytochrome P-450IA1 induction, delayed increased mortality, decreased feed consumption, decreased body weight, and epithelial and lymphomyeloid lesions (Sijm and Opperhuizen, 1996). Recently, a fish tissue residue benchmark of 0.344 ng TCDD-TEQ/g lipid was proposed to protect 95% of species, assuming a 1:1 ratio egg to maternal fish (Steevens et al. 2003). Fin rot or fin erosion has been observed in Complex fishes during studies of fish-eating birds (Parsons, 1994).

Fish Advisories: The Complex lies within a large metropolitan area that once provided valuable recreational and commercial fishing services to the surrounding communities.

Consumption advisories and sale prohibitions were first issued in 1983-1984 due to elevated levels of dioxins and PCBs in fish and shellfish (Belton *et al.,* 1985; Belton *et al.,* 1988; Hauge *et al.,*1990; Hauge *et al.,* 1994). Fishing and crabbing advisories have been in effect for approximately 20 years as a result of dioxin and PCB contamination within the Complex (NJDEP, 2002a, b; see Table 4.).

Table 4. Fish and Crab Consumption Advisories Based on PCBs and Dioxin Contamination (excerpted from A Guide to Health Advisories for Eating Fish and Crabs Caught in New Jersey Waters, NJDEP, 2002b)

Location	Species	General Population	High Risk Individual[1]
Newark Bay Complex			
Passaic River downstream of Dundee Dam and all feeder streams	All fish and shellfish*	Do not eat	Do not eat
	Blue crab*	Do not eat or harvest	Do not eat or harvest
Newark Bay, Hackensack River downstream of Oradell Dam, Arthur Kill, Kill Van Kull, tidal portions of all rivers and streams that feed into these water bodies.	Striped bass*	Do not eat	Do not eat
	American eel*	Do not eat more than once a week	Do not eat
	Blue crab*	Do not eat or harvest	Do not eat or harvest
	Bluefish, white perch, white catfish	Do not eat more than once a week	Do not eat

* Selling any of these species from designated water bodies is prohibited in New Jersey. [1] High risk individuals include: infants, children under the age of 15, pregnant women, nursing mothers and women of childbearing age. They are advised not to eat any such fish or crabs taken from the designated regions since these hazardous substances have a greater impact on the developing young.

A recent update recommended more restrictive meal frequencies for several species (NJDEP, 2003b) (see Table 5.). Despite these advisories, fishermen routinely ignore the warnings and continue to take their catch home to feed their families (NJDEP, 2002a) and anglers are still often observed fishing in the Passaic River, including within the confines of the PRSA .

Avian and Mammalian Resources: Over 70 species of birds are known to use habitats in the Complex, including approximately 1,200 pairs of colonial wading birds such as black-crowned night-herons, yellow-crowned night-herons, little blue herons, green herons, and great, snowy, and cattle egrets (USFWS, 1996). Elevated concentrations of 2,3,7,8-TCDD and 2,3,7,8-TCDD TEQs in prey items and double-crested cormorant eggs indicates that birds and small mammals in the Passaic River area are at risk from 2,3,7,8-TCDD-like contamination (see Table 6.). Parsons (2003) similarly claims birds are at risk, based on egg residues found in double-crested cormorants.

The Canadian Tissue Residue Guidelines (TRG) for the protection of wildlife consuming dietary prey is between 2.4 pptr as PCB-TEQ and 4.75 pptr as PCDD/DF TEQ for birds and 0.79 pptr as PCB TEQ and 0.71 pptr as PCDD/DF TEQ for mammals (CCME, 2001a; CCME, 2001b; CCME, 2001c). In environments where both PCBs, PCDDs and PCDFs contribute significantly to the TEQ concentration in aquatic prey items such as the Newark Bay Complex, the Canadian Ministers recommended that the lower value between the PCB and PCDD/PCDF TRGs take precedence as the total TEQ

concentration (i.e., PCB and PCDD/PCDF TEQs combined) in aquatic biota to protect wildlife consumers against the common mode of action shared by these chemicals.

Table 5. Fish and Crab Consumption Advisories Based on PCBs and Dioxin Contamination in effect beginning 2003 (NJDEP, 2003b).

Location	Species	General Population Recommended Meal Frequency[2]		High Risk Individual[1] Recommend-ed Meal Frequency[2]
		Lifetime Cancer Risk of 1 in 10,000	Lifetime Cancer Risk of 1 in 100,000	
Newark Bay Complex				
Passaic River downstream of Dundee Dam and all rivers and streams that feel into this section of river	All fish and shellfish* Blue crab*	Do not eat Do not eat or harvest[3]	Do not eat Do not eat or harvest	Do not eat Do not eat or harvest
Newark Bay, Hackensack River downstream of Oradell Dam, Arthur Kill, Kill Van Kull, tidal portions of all rivers and streams that feed into these water bodies.	Striped bass* Blue crab* American eel*, White perch, white catfish	Do not eat Do not eat or harvest Do not eat more than once a year	Do not eat Do not eat or harvest Do not eat	Do not eat Do not eat or harvest Do not eat
Statewide	Bluefish >6lbs, 24 inches Bluefish <6lbs, 24 inches Lobster[4]	Do not eat more than four meals per year Do not eat more than once per month Do not eat hepatopancreas	Do not eat Do not eat more than once per year Do not eat hepatopancreas	Do not eat Do not eat Do not eat hepatopancreas

* Selling any of these species from designated water bodies is prohibited in New Jersey.
[1] High risk individuals include infants, children, pregnant women, nursing mothers and women of childbearing age.
[2] Assumes serving size of 8 oz. fillet.
[3] No harvest means no taking or attempting to take any blue crabs from these waters.
[4] Advisory for lobster and Newark Bay Complex based on dioxin except for white perch, white catfish and American eel where advisory is based on PCBs.

To illustrate the relative severity of contamination in the Complex by 2,3,7,8-TCDD alone, the Trustees note that out of 180 biota samples recently collected in the PRSA, 98.3% and 97.7% exceeded these Canadian avian and mammalian protective dietary guidelines respectively.

2,3,7,8-TCDD TEQs associated with embryotoxicity and developmental effects in Great Lakes region double-crested cormorant field studies range from 350-1300 pptr based on chemistry and 85-413 pptr based on *in vitro* egg extract bioassay (Hoffman *et al.*, 1996).

2,3,7,8-TCDD concentrations in double-crested cormorant eggs collected from within the Complex ranged from 16-241 pptr. Additionally, eggs collected from the Complex were analyzed for 2,3,7,8-TCDD-like compounds. 2,3,7,8-TCDD TEQs ranged from 254-767 pptr in five eggs from Shooters Island. The contribution of 2,3,7,8-TCDD to total 2,3,7,8-TCDD-TEQ ranged from approximately 6 to 25 percent. Total PCDD/PCDF TEQ concentrations in these samples contributed between 11 to almost 38% of the total. Total 2,3,7,8-TCDD-TEQs originating from 2,3,7,8-TCDD-like PCBs, PCDDs and PCDFs were within the reported field effects range, indicating a high likelihood for demonstrating injuries in this species as well as others.

Table 6. 2,3,7,8-TCDD and/or 2,3,7,8-TCDD TEQs[1] from PCBs, PCDDs and PCDFs in birds and fish of the Newark Bay Complex

Species	n	Range (pptr)	Average + Std Dev(pptr)
Double-crested Cormorant eggs (USFWS, 1997)	8	44 - 161[a]	83 ± 38
		16 - 241[a]	103 ± 95
		220 - 680[b]	464 ± 147
		34 - 289[ac]	138 ± 96
Double-crested Cormorant eggs (USFWS, 2000a)	5	254 – 767[d]	604 ± 189
Striped bass (USFWS, 2000a) whole body minus liver (14-25cm)	5	7 – 69[a]	31 ± 23
White perch (USFWS, 2000a) whole body presume adult based on length.	5	99 - 208[a]	153 ± 46

[1] TEQs based on Toxicity Equivalency Factors for birds reported in Van den Berg et al., 1998.
[a] TEQ based on 2,3,7,8-TCDD only.
[b] TEQ based on coplanar PCBs only.
[c] TEQ based on sum of PCDDs and PCDFs.
[d] TEQ based on sum of PCDDs+PCDFs+PCBs.

Using biomagnification factors described by Hoffman *et al.* (1996) for herring gulls, it is estimated that birds feeding exclusively on fish with mean 2,3,7,8-TCDD concentrations of 25 (bass) to 100 (white perch) pptr may produce eggs containing 500 to 2,000 pptr, which is lethal for sensitive avian embryos. These values are within the range of concentrations reported for prey species within the Passaic River, where bird egg data are unavailable, suggesting strong likelihood for injuries to birds consuming 2,3,7,8-TCDD contaminated prey. Other 2,3,7,8-TCDD-like compounds will add still more risk of injury.

In egg injection studies, high concentrations (4,000 pptr) caused statistically significant increases in cormorant embryo mortality compared with controls (Powell *et al.*, 1997). Unlike artificially incubated eggs dosed with toxicants like 2,3,7,8-TCDD, naturally incubated eggs are more susceptible to mortality because of aberrant nesting and nest attentiveness by adults (Kubiak *et al.,* 1989; Gilbertson *et al.,* 1991). Observations of reduced egg viability among colonial nesting water birds on Shooters Island are preliminary evidence that trust resources have been injured as a result of exposure, via

bioaccumulation and food chain transfer, to hazardous substances in Newark Bay Complex sediments (Parsons, 1994). Nesting waterbirds have heavily utilized the forage base of the Shooters Island "drift field" (Parsons, 1994).

3.3 Potentially Affected Resources and Resource Services

A wide range of natural resources and natural resource services under Federal or State Trusteeship are affected or potentially affected by the release of dioxins, furans and other hazardous substances released at and from the Site. These natural resources provide a variety of ecological and human services. Potentially affected resources and the services they provide are described further below.

3.3.1 Surface Water and Sediment Resources and Services

The sediment and surface waters of the Site and the services these media provide have been affected by dioxin and furan contamination. The surface waters of this system provide habitat for fish and shellfish species, including feeding, breeding, and nursery services (see Appendix 1). In addition, these waters support both consumptive and non-consumptive recreational activities such as recreational fishing, swimming, boating, and wildlife viewing.

River sediments, like surface water, serve as a medium for the transport of energy and nutrients, and as breeding, feeding, and nursery habitat for various aquatic biota, including benthic finfish and shellfish species. As noted above, elevated dioxin and furan levels have been reported in sediments throughout much of the Passaic River and the Complex (Bopp *et al.*, 1991; Tong *et al.*, 1990; USFWS, 2000b). River sediments are believed to be the major sink for PCDD/DFs within the Site and are a continuing source of contamination to biotic and abiotic resources throughout the estuary. The historical record indicates buried sediments in the Passaic River have exceeded the 25 ppb 2,3,7,8-TCDD value reported as a NOAEL, causing toxicity to *Ampelisca abdita* (Barber *et al.,* 1998), and are well above the "Probable Apparent Effects Threshold" or PAET of 0.0072 ug/g derived by Cubbage *et al.,* (1997) for the amphipod, *Hyallela azteca.* Iannuzzi *et al.,* (1995) reviewed literature on development of sediment criteria for 2,3,7,8-TCDD. Gale *et al.,* (2000) provide recent evidence for the PAH fraction of sediment in Newark Bay to be a larger component of dioxin-like activity using the H4IIE cell extract bioassay.

As noted in 3.2.3 above, surface and subsurface 2,3,7,8-TCDD and PCBs are at levels that contribute to continued fish consumption bans and advisories and pose risk to fish and wildlife throughout the Complex.

Marine transportation is an important economic service provided by the Complex. The presence of 2,3,7,8-TCDD and other hazardous substances in sediments has hindered dredging and maintenance activities for the purposes of navigation in the Port of New York and New Jersey, resulting in restricted disposal options and increased costs.

3.3.2 Biotic Resources and Services

Fishery Trust Resources

NOAA, USFWS and NJDEP trust habitats of primary concern for this Preassessment Screen include the tidal waterways of the Complex (see Figure 1.). Appendix 1 is a compilation of aquatic species that have been collected within the Complex by several agencies. USFWS (1996) has identified numerous significant fish, wildlife, and vascular plant habitats or sub-areas on Staten Island and in New Jersey. The Arthur Kill system (including, but not limited to the Arthur Kill and Kill van Kull and associated wetlands and tributaries) supports 178 species, including 37 fish and 128 birds. Wilk *et al.* (1997) collected 56 species of fish and megainvertebrates in Newark Bay by otter trawl tows and gill nets. The dominant species were striped bass, Atlantic tomcod, blue crab, white perch, weakfish, winter flounder, spotted hake, rainbow smelt, Atlantic herring, bay anchovy, Atlantic silverside, summer flounder, bluefish, Atlantic menhaden, alewife, and grubby with abundance dependent upon sampling equipment. The Hackensack Meadowlands Commission documented 73 species of fish and invertebrates in the Hackensack River (Bragin, 2001). Both the Arthur Kill and Kill van Kull are used as migratory corridors by numerous anadromous and marine species that utilize the Passaic and Hackensack Rivers and Newark Bay. The distribution of marine species is dictated by the movement of the salt wedge that extends approximately 12 km upstream to just below the Second River tributary.

A wide variety of fish use the Newark Bay Complex for spawning, nursery areas, and foraging. At least 25 species utilize the Newark Bay Complex for spawning (see Appendix 1). Species such as blueback herring, alewives, American shad, striped bass, bay anchovy, mummichog, striped killifish, and white perch spawn within the Passaic River. Alewife, shad and herring typically migrate upriver in the spring to spawn in less saline waters. Spawning in the Passaic occurs above the mouth of the Second River as well as in the Third and Saddle Rivers but not in the Second River. Fish spawning habitat on the Passaic River is limited to below Dundee Dam because of the absence of fish passage facilities.

A larger list of species use the area as a nursery. The tidal freshwater sections of the Passaic (from Dundee Dam to the mouth of the Second River) function as the principal nursery areas. Brackish water and marine species, identified in Appendix 1 use the lower, saline portions of the Passaic for adult and nursery habitat. Their distribution depends on the salt wedge. Resident euryhaline species include white perch, mummichog, and striped killifish which spawn and develop within the estuary and are distributed throughout the system. Blue crab use the lower brackish portion of the estuary as a nursery and adult habitat. The American eel uses the main rivers, kills and tributaries for adult habitat.

Studies of the resident, native killifish or mummichog, indicate an insensitivity to actual 2,3,7,8-TCDD and to the most potent dioxin-like PCB congener, PCB 126 (Prince and Cooper, 1995a; Prince and Cooper, 1995b; Nacci, 2002). These studies demonstrate a

dramatic shift to a current resident subpopulation of individuals that are highly resistant to 2,3,7,8-TCDD toxicity. Despite this resistance, Newark Bay mummichogs also exhibit greater parasitic infestations of the liver, greater hepatic neoplasias, and greater liver-to-body weight ratios, and have greater basal liver ethoxyresorufin-*o*-deethylase (EROD) enzyme activity than reference population fish at Tuckerton, New Jersey. The causative agent for these conditions was not addressed in these studies and would need further elucidation during preliminary assessment planning.

Studies of planar halogenated organic compounds, like 2,3,7,8-TCDD, consistently have demonstrated the lack of invertebrate sensitivity, even at the high study concentrations reported in Barber *et al.,* (1998). However, virtually all studies have relied on acute or limited life-cycle testing that did not address endpoints such as fecundity, fertility, egg mortality or early life stage mortality. In controlled laboratory exposures, Wintermyer and Cooper (2003) recently demonstrated the extreme sensitivity of the American oyster (*Crassostrea virginica)* to 2,3,7,8-TCDD, with effect concentrations as low as 2 pptr in adductor muscle. These experiments resulted in significant decreases in gametogenesis (gonadal development) and egg viability in 2,3,7,8-TCDD-exposed oysters relative to controls. This laboratory experiment supported a complimentary field exposure/effect study. Tissue concentrations of 2,3,7,8-TCDD observed in Newark Bay and Arthur Kill study locations were similar to the 2 pptr effect level in the laboratory study. Field effects could not be solely attributed to 2,3,7,8-TCDD. The authors noted that transplanting oysters into the Newark Bay and the Arthur Kill field study sites at this time would not result in successful oyster recruitment of the bay area. Lastly, invertebrates can accumulate high concentrations of 2,3,7,8-TCDD and other dioxin-like compounds, resulting in bioaccumulation up the food chain, contributing to consumption advisories and risk to piscivorous wildlife.

Avian Trust Resources

Approximately 1,200 pairs of colonial, nesting, wading birds, known as the "Harbor Herons" have been documented to breed and nest on Shooters Island in lower Newark Bay, Prall's Island, and the Isle of Meadows in the Arthur Kill (USFWS, 1996). The Harbor Herons include black-crowned night-herons, yellow-crowned night-herons, little blue herons, green herons, great egrets, snowy egrets, cattle egrets, and glossy ibises. Shooters Island alone has provided nesting habitat for rapidly increasing numbers of wading birds, seabirds (including double-crested cormorants), waterfowl, and song birds (Parsons, 1994). Breeding use has been reduced dramatically in recent years. At least one marsh hawk pair has been observed nesting in the upland-salt marsh fringe and peregrine falcons nest on bridges crossing the Arthur Kill. The USFWS has designated Prall's Island, Isle of Meadows, and several other areas in the Arthur Kill as priority wetland sites (USFWS, 1996).

Exposure of Biotic Resources

As noted in Section 3.2, above, elevated levels of dioxins, furans and PCBs have been detected in various aquatic and avian resources in the Newark Bay Complex (Brown *et*

al., 1994; Cai *et al.*, 1994a; Long *et al.*, 1995; USFWS, 2000a,b; NOAA, 2004; Parsons, 2003). 2,3,7,8-TCDD concentrations in biota are at levels that pose risk to aquatic and piscivorous wildlife and have resulted in fish consumption bans, advisories and commercial fishing bans. Waterfowl, such as Canada geese and diving ducks, have not been chemically characterized and assessed for consumption risk. While there are no Federal tolerances or other administrative levels for dioxins in food or feed, the U.S. Food and Drug Administration (USFDA) has restricted the importation of animal products such as eggs. In order for egg products to be released from detention in 1999, importers had to provide laboratory test results showing PCBs were not detectable and/or that dioxins did not exceed 1 pptr (USFDA, 1999). The USFDA also restricted the sale of catfish domestically until it could be ascertained that fish did not contain above background levels of dioxins. The sampling and testing program was designed to ensure that catfish that might contain dioxin in amounts of 1 pptr or greater did not enter commercial channels. The 1 pptr level was carefully chosen as a threshold that would identify food from animals which had consumed dioxin-contaminated feed while allowing products with background levels of dioxin to move into commerce. It was not intended to serve as a permanent standard for dioxin in human food, but rather is a reasonable cut-off level for this episode of known, avoidable dioxin contamination of human food from a single source (USFDA, 1997). The Federal CWA, under § 1313(d)[21], requires states to identify "Impaired Waters," where specific designated uses are not fully supported. For these waters, the state is required to establish total maximum daily loads (TMDLs) in accordance with a priority ranking. § 1315(b)[22] of the CWA also requires States to periodically assess and report on the overall quality of waters in their state. The Lower Passaic River has been determined to be impaired for fish consumption due to the fish advisories for these waters. A non-attainment designation for dioxin and PCBs in fish[23] is listed in the 1315(b) report for the Lower Passaic River (estuary and tributaries) due to the presence of these contaminants in fish from these waters. Development of TMDLs is scheduled for 2006 for these parameters.

In 1983, based on dioxin data collected by the NJDEP and USEPA, (Belton *et al.,* 1985) and in accordance with Federal and State statutes, the NJDEP issued a fish consumption advisory for the tidal Passaic River that prohibited the sale or consumption of all fish and shellfish (N.J. Administrative Order No. EO-40-17). The advisory was based on a comparison of tissue levels in fish and crabs to the USFDA's advisory opinion on "levels of concern" for TCDD (USFDA, 1981 and 1983). Based on an evaluation of toxicity data and fish consumption, USFDA recommended that fish that exceed 50 pptr 2,3,7,8-TCDD should not be consumed.

3.3.3 Groundwater Resources and Services

Services from groundwater include regulation of water flows and water recharge to the estuary and serving as a supply for a variety of public and industrial uses. Contaminated groundwater can also act as a pathway to contamination of other natural resources. Per

[21] 33 USC 1250, et seq., at 1313(d).
[22] 33 USC 1250, et seq., at 1315(b).
[23] http://www.state.nj.us/dep/wmm/sgwqt/wat/integratedlist/integratedlist.htm.

Section 3.1.2, limited sampling indicates that the groundwater at this site acts as a recharge for the Passaic River and is contaminated with 2,3,7,8-TCDD above the MCL and NJGQC. Most samples collected had detectable 2,3,7,8-TCDD levels up to a maximum of 10.4 ppb.

4.0 Preliminary Determination Regarding Preassessment Screen Criteria

In accordance with the DOI Natural Resource Damage Assessment Regulation[24], the Trustees have determined that all of the following criteria have been met.

4.1 Criterion 1 - A Release of a Hazardous Substance has Occurred

The Diamond Alkali Plant was predominately used from 1951 to 1977 for pesticide and herbicide production. Dioxins and furans as well as other hazardous substances associated with the Site originated from 2,4,5-T production (IT Corporation, 1985a, 1985b; IT Corporation, 1986; USEPA, 1987).

An explosion in the trichlorophenol unit during February 1960 destroyed the large five-story building in which trichlorophenol and other plant processes were located. Dioxins and furans are a byproduct of the production of trichlorophenol and are also produced during combustion. The explosion at the Site released dioxins and furans into the Lower Passaic River. Additionally, the direct, intentional, and illegal chemical waste discharges to the Lower Passaic River between 1951 and 1969 are documented in court records (Diamond Shamrock v. Aetna Casualty and Surety Company *et al.,* 1989). Groundwater is also a likely source of contamination to the river. Inundation of the Plant during storms associated with tidal surges also has contributed to the release of hazardous substances to the river (USEPA, 1987). Section 2 provides additional detail concerning this criterion.

4.2 Criterion 2 - Natural Resources for which the Trustees may assert trusteeship under the Comprehensive Environmental Response, Compensation, and Liability Act have been or are likely to have been adversely affected by the release

The natural resources adversely affected by releases of dioxins and furans and the exposed areas are within the jurisdiction of the Trustees as defined under CERCLA. Section 3 addressed the specific resources under trusteeship which include: surface water and sediments, groundwater, air, biota, and geologic resources such as floodplain soils and upland surficial soils. Currently, the primary area of concern associated with releases at and from the Site include associated waterways of the Newark Bay Complex including the tidal reaches of the Passaic and Hackensack Rivers, Newark Bay, Arthur Kill, and the Kill van Kull.

A 1989 civil action (Diamond Shamrock v. Aetna Casualty and Surety Company et al. 1989) addresses this criterion. The opinion states that "from 1951 to 1969 Diamond had

[24] At 43 CFR Part 11.23(e).

a mindset and a method of conducting manufacturing operations which were destructive of the land, air, and water resources of the environment." It goes on to say that "even by standards of the 1951-1969 period, Diamond's conduct in operating the Newark plant was unacceptably wrong and irresponsible...it deliberately and persistently cheated on the limited environmental regulations which were in place." (pp. 11-12).

4.3 Criterion 3 - The Quantity and Concentration of the Released Hazardous Substance is Sufficient to Potentially Cause Injury to Natural Resources

Bopp *et al.* (1991) estimated that 4-8 kg of 2,3,7,8-TCDD has been released from the Diamond Alkali Plant over 40 years. Results of several studies indicate that aquatic and piscivorous wildlife in the Complex are experiencing significant exposure to PCDDs from the Diamond Alkali Site (see Section 3.2). Results of several studies and data compilation (USFWS, 1997, 2000a,b; NOAA, 2004; and Parsons, 2003) indicate that anadromous fish and piscivorous birds in the Newark Bay Complex are experiencing significant exposure to 2,3,7,8-TCDD and related compounds associated with the Site. In addition, 2,3,7,8-TCDD concentrations in striped bass and white perch (USFWS, 2000a) are sufficient to pose risk of significant exposure to avian predators through biomagnification into avian eggs.

The Newark Bay Complex lies within a large metropolitan area that once provided valuable recreational and commercial fishing services to the surrounding communities. As a result of dioxin and PCB contamination, fishing and crabbing advisories exist for the Complex (NJDEP, 2002a,b; 2003b). Refer to Section 3.2 and Table 5 for consumption advisory details.

While Trustees are initially concerned with 2,3,7,8-TCDD, PCBs and PCDFs exert similar toxicological effects in vertebrate organisms. They will be addressed in a manner that identifies all natural resource injuries and properly addresses related damages, which are associated with final remediation goal identification and success of remediation measures. The Trustees acknowledge the need to address Site-related issues consistently and holistically based on all new and historic information, including any forthcoming Remedial Investigation and Feasibility Studies as well as other Site-related data acquisition.

4.4 Criterion 4 – Data Sufficient to Pursue an Assessment Are Readily Available or Are Likely to be Obtained at a Reasonable Cost

Significant amounts of data relevant to natural resources and potential injuries resulting from exposure to dioxins in the Passaic River and its environs are available from NJDEP, USFWS, USEPA, NOAA, Occidental Chemical, and other sources. These data include information on hazardous substance releases, concentrations in the environment, and the effect of contamination on natural resources. Given the volume of available information and the additional information to be collected outside of NRDA activities, additional data useful for an assessment could be obtained at a reasonable cost.

4.5 Criterion 5 - Response Actions Carried Out or Planned Do Not or Will Not Sufficiently Remedy the Injury to Natural Resources Without Further Action

The Trustees do not expect that the remedial measures carried out or planned will fully address the various sources and pathways of exposure of natural resources to dioxins, or the past, current, and future injuries resulting from such exposure. Therefore, the Trustees have determined that the response actions carried out or currently planned do not or will not sufficiently remedy the injury to restore the injured natural resources of the Passaic River and the greater Complex without further action.

5.0 Conclusion

Following the review of information described in this Preassessment Screen, the Trustees have made a preliminary determination that the criteria specified in the CERCLA Natural Resource Damage Assessment Regulation have been met. The Trustees have further determined that there is a reasonable probability of making a successful claim for damages with respect to natural resources over which the Trustees have trusteeship. Therefore, the Trustees have determined that assessment of natural resource damages is warranted.

The State of New Jersey:

By:_____ Date: November 8, 2005

Bradley M. Campbell
Commissioner
New Jersey Department of Environmental Protection
For the State of New Jersey

The U.S. Department of the Interior:

By: Anthony D. Léger ACTING Date: OCT - 5 2004

Marvin Moriarty
Regional Director
Northeast Region, U.S. Fish and Wildlife Service
For the United States Department of the Interior

The National Oceanic and Atmospheric Administration

By: _____ Date: 8/16/04

David Kennedy
Director
Office of Response and Restoration
National Oceanic and Atmospheric Administration
For the United States Department of Commerce

Appendix 1

Federal and State trust aquatic resources using the Newark Bay Complex (Passaic River, Hackensack River, Newark Bay, Arthur Kill, Kill Van Kull)

Common Name	Species	Spawn Area	Nursery Area	Adult Area	Comm. Fishery[6]	Recr. Fishery[7]
Anadromous/Catadromous						
Alewife[1,2,4,5]	*Alosa pseudoharengus*	*[9]	*	*		
Blueback Herring[1,2,3,4,5]	*Alosa aestivalis*	*[9]	*	*		
American Shad[1,2,4,5]	*Alosa sapidissima*	*[9]	*	*		*
American Eel[1,2,3,4,5]	*Anguilla rostrata*		Maybe	*	*	*
Striped Bass[1,2,3,4,5]	*Morone saxatilis*	*[9]	*	*	*	*
Estuarine/Marine						
Bay Anchovy[1,2,4,5]	*Anchoa mitchelli*	*	*	*		
Silver Perch[1,5]	*Bairdiella chrysoura*		*			
Atlantic Menhaden[1,2,3,4,5]	*Brevooretia tyrannus*	*	*	*	*Bait	
Weakfish[1,2,4,5]	*Cynoscion regalis*	*	*	*	?	*
Mummichog[2,3,4,5]	*Fundulus heteroclitus*	*	*	*	Possibly Bait	
Striped Bass[1,4,5]	*Fundulus majalis*	*	*	*		
Spot[1,2,4,5]	*Leiostomus xanthurus*		*	*		*
Atlantic Croaker[1,5]	*Micropongonias undulates*		?	?		*?
White Perch[1,2,3,4,5]	*Morone americana*	*[10]	*	*		*
Summer Flounder[1,2,4,5,8]	*Paralichthys dentatus*		*	Rare		*

Common Name	Species	Spawn Area	Nursery Area	Adult Area	Comm. Fishery[6]	Recr. Fishery[7]
Bluefish[1,2,4,5,8]	*Pomatomus saltatrix*		*	*		*
Winter Flounder[1,2,4,5,8]	*Pseudopleuronectes americanus*	*	*	*		
Gizzard Shad[1,3,4,5]	*Dorosoma cepedianum*		*	*		*
Hogchoker[1,2,3,4]	*Trinectes maculatus*	*	*	*		
Atlantic Sturgeon[1]	*Acipenser oxyrhynchus*			Rare		
Conger Eel[1,4]	*Congridae sp.*		*			
Atlantic Herring[1,4,8]	*Clupea harengus*		*	*		
Little Skate[1,4]	*Raja erinacea*			?		
Rainbow Smelt[1,4,5]	*Osmerus mordax*		*	*		
Atlantic Tomcod[1,2,4,5]	*Microgadus tomcod*	?	*	*		
Red Hake[1,2,4,8]	*Urophycis chuss*		*	*		?
Spotted Hake[1,4]	*Urophycis regia*		*	*		
Atlantic Silverside[1,2,4]	*Menidia menidia*	*	*	*		
Inland Silverside[2,4]	*Menidia beryllina*		?	?		
Tidewater Silverside[4,5]	*Menidia pensinisulae*	*	*	*		
Three-Spined Stickleback[1,4,5]	*Gasterosteus aculeatus*	*	*	*		
Northern Searobin[1,2,4]	*Prinotus carolinus*		*	*		
Striped Searobin[1,2,4]	*Prinotus evolans*		*	*		
Lined Seahorse[1]	*Hippocampus erectus*			*		
Northern Pipefish[1,2,4]	*Syngnathus fuscus*		*	*		
Grubby[1,2,4]	*Myoxocephalus aenaeus*			*		
Crevalle Jack[1,4]	*Caranz hippos*		*			
Scup[1,2,4,8]	*Stenotomus chrysops*		?	*	*	*
Northern Kingfish[1]	*Menticirrhus saxatilis*		*	*		?
Tautog[1,2,4]	*Tautoga onitis*	*	*	*		?
Cunner[1,2,4]	*Tautogolabrus adspersus*			*		
Rock Gunnel[1,4]	*Pholis gunnellus*		*	*		
Goby[1,2,4]	*Gobiosoma sp.*	*	*	*		
Butterfish[1,2,4,8]	*Peprilus triacanthus*		*	*	*	

Common Name	Species	Spawn Area	Nursery Area	Adult Area	Comm. Fishery[6]	Recr. Fishery[7]
Striped Mullet[2,4]	*Mugil cephalus*		*	*		
Smallmouth Flounder[1,4]	*Etropus microstomus*			*		
Fourspot Flounder[1,4]	*Paralichthys oblonogus*			*		
Windowpane[1,2,4,8]	*Scophthallmus aquosus*	*	*	*		
Oyster Toadfish[2]	*Opsanus tau*	*	*	*		
Planehead Filefish[1]	*Monacanthus hispidus*			?		
Northern Puffer[1]	*Sphoeroides maculatus*			?		
Atlantic Needlefish[2]	*Strongylura narina*		*	*		
Silver Hake[2,4,8]	*Merluccius bilinearis*		*	*	*	?
Pollock[2,4,8]	*Pollachius virens*		Very Rare		*	
Black Sea Bass[2,4,8]	*Centropristis striata*		Very Rare		*	
Smooth Dogfish[2]	*Mustelus canis*			Possibly		
Sheepshead[4]	*Archesargus probatocephalus*			Formerly		
Northern Stargazer[4]	*Astroscopus guttatus*			*		
American Sand Lance[4]	*Ammodytes americanus*	*	*			
White Mullet4	*Mugil curema*			?		
Atlantic Moonfish[4]	*Selene setapinnis*			?		
Smooth Trunkfish[4]	*Lactophrys triqueter*			?		
Striped Burrfish[4]	*Cyclichthys schoepfi*			?		
Striped Anchovy[4]	*Anchoa hepsetus*			*		
Longhorn Sculpin[4]	*Myoxocephalus octodecem-spinosus*					
Naked Goby[4]	*Gobiosoma bosci*	*	*	*		
Seaboard Goby[4]	*Gobiosoma ginsburgi*			*		

Common Name	Species	Spawn Area	Nursery Area	Adult Area	Comm. Fishery[6]	Recr. Fishery[7]
Fourbeard Rockling[4]	*Enchelyopus cimbrius*	*				
Striped Cusk-eel[4]	*Ophidion marginatum*		*			
Freshwater Species						
Channel Catfish[3]	*Ictalurus punctatus*			*		?
White Catfish[3,4]	*Ameiurus catis*			*		?
Goldfish[4,5]	*Carassuis auratus*			*		
Pumpkinseed[4,5]	*Lepomis gibbosus*			*		?
Bluegill[4,5]	*Lepomis macrochirus*			*		?
Largemouth Bass[5]	*Micropterus salmoides*			*		?
Black Crappie[4,5]	*Pomoxis nigromaculatus*			*		?
Red Breasted Sunfish[4]	*Lepomis lauritus*			*		
Brown Bullhead[3,4,5]	*Ameiurus nebulosus*			*		
Golden Shiner[4]	*Notemigonus crysoleucas*			*		
Carp[3,4,5]	*Cyprinus carpio*			*		
White Sucker[3]	*Catostomus commersoni*			*		
Northern Pike[12]	*Esox lucius*			*		
Invertebrate						
Blue Crab[1,3,4,5]	*Callinectus sapidus*		*	*	*	*
Atlantic Rock Crab[1]	*Cancer irroratus*		*	*		
Spider Crab[1]	*Libinia emarginata*		*	*		
Lady Crab[1]	*Ovalipes ocellatus*			*		
Grass Shrimp[1,3,4]	*Paleomonetes pugio*	*	*	*		
Mantis Shrimp[1]	*Squilla empusa*			*		
American Oyster[1,4]	*Crassostrea virginica*	*	*	*	formerly ?	
Horseshoe Crab[1]	*Limulus polyphemus*		?	?		

Common Name	*Species*	Spawn Area	Nursery Area	Adult Area	Comm. Fishery[6]	Recr. Fishery[7]
Softshell Clam[1]	*Mya arenaria*	*	*	*	?	?[11]
Hard Clam	*Mercenaria mercenaria*	?	?	*	?	?[11]
Blue Mussel	*Mytilus edulis*			*		?[11]

[1] Wilk et al. (1997).

[2] USFWS (1997).

[3] Passaic River Study Area Ecological Sampling Plan 1999-2000 targeted species CLH (1999) and incidental catch on the Passaic River Stitt, C (2000).

[4] Bragin pers. comm. (2001), and PSEG (1998)

[5] Papson et al. (1981); Zich (1978); USFWS (1980); RPI (1985).

[6] Commercial fishing (all fish and shellfish) in the tidal Passaic River (downstream of Dundee Dam) has been prohibited since 1983 for all species due to dioxin contamination. Newark Bay, Tidal Hackensack, Arthur Kill and Kill Van Kull prohibitions were posted starting in 1984 for striped bass and crabs. Currently, there is a ban on selling striped bass, American eel, and blue crab from Newark Bay, Hackensack River below Oradell Dam, Arthur Kill, Kill Van Kull, and associated tidal tributaries due to contamination by dioxin and PCBs. (http://www.state.nj.us/dep/dsr/fish-crab.htm).

[7] There are consumption advisories for all fish and shellfish on the Passaic River between Dundee Dam and Newark Bay due to dioxin and PCB contamination. Harvesting of blue crabs is prohibited in the Newark Bay Complex. For Newark Bay, Arthur Kill, Kill van Kull, and Hackensack River below Oradell Dam, there are consumption advisories for blue crab, American eel, American lobster (hepatopancreas), striped bass, white perch, white catfish and blue fish ranging from do not eat to eat no more than one meal per week depending on species and risk category. (http://www.state.nj.us/dep/dsr/fish-crab.htm).

[8] Federally managed species for which essential fish habitat (EFH) has been designated pursuant to the Magnuson-Stevens Act.

[9] Spawn upstream in Hackensack and Passaic Rivers, but not in Newark Bay.

[10] Generally spawn in freshwater.

[11] General recreational harvesting, but not in Newark Bay.

[12] Stocked in Passaic River above Dundee Dam. Presence below dam due to upstream stocking (Papson, 2002. pers. comm.).

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